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ENVIRONMENTAL MONITORING OF FOREST

INSECT CONTROL OPERATIONS

(EMOFICO)

1984 REPORT

Material in this report may not be cited without consultation with the contributors

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F O R E W O R D

The New Brunswick Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO) is a loose association of biologists, foresters, environmental specialists and chemists from federal and provincial governments, industry and universities. Its prime objective is to assess the impact of operational spray programs on non-target organisms and ecological processes in forest and adjacent ecosystems. By implication this includes experimental sprays and complementary laboratory studies. Efficacy is also considered, in sofaras it relates to environmental effects. Potential consequences of forest spray programs for human health are beyond the Committee's terms of reference. Although the Committee's focus is on spray activities in New Brunswick, it seeks to keep aware of forest insect control operations and related environmental studies elsewhere in the Atlantic region as well as in Quebec and Maine.

The Committee assumed its present name and structure in 1976, and has been under the aegis of Environment New Brunswick (now the Department of Municipal Affairs and Environment) since 1980. The 1984 report, like its predecessors, is aimed at a broad readership - scientists, regulators, resource managers and, not the least importantly, the public. It consists essentially of preliminary reports and abstracts of reports completed.

For further information on the role of the New Brunswick Committee for EMOFICO as well as an instructive statement on insecticide ecology, the reader is referred to the Committee's combined 1978-1979 report.

Steering Committee

D. I. Besner (Department of Municipal Affairs and Environment)- chairman
D. C. Eidt (Canadian Forestry Service)
P. A. Pearce (Canadian Wildlife Service)
W. A. Sexsmith (Department of Municipal Affairs and Environment) - secretary

RECOMMENDATIONS

A Consensus of the EMOFICO Committee

It is recommended:

(1) that government agencies continue to support research and monitoring proposals.

(2) that regulatory agencies continue to review the rationale for the specifications for buffer zones recognizing that much work has been done in the area of spray technology.

(3) that monitoring, research, and regulatory agencies make a greater effort to explain to the public the significance of their findings.

(4) that the potential environmental implications of the use of **Bacillus thuringiensis.** be clarified.

(5) that monitoring and research agencies continue studies on the fate and persistence of pesticide active ingredients, spray adjuvants, and their breakdown products in various components of the environment.

(6) that further work be encouraged on the biological significance of pesticide residues in the forest environment.

(7) that continued liason with provincial monitoring groups in other juridictions be encouraged.

OPERATIONAL SPRAYING

SPRUCE BUDWORM PROTECTION PROGRAM IN NEW BRUNSWICK - 1984

N. Carter*

In 1984, Forest Protection Limited aerially applied insecticides to 1.03 million ha of spruce budworm infested forest land in New Brunswick. Approximately 85 % of the area received a double application of either fenitrothion (Sumithion) or aminocarb (Matacil 180F) insecticide in water-based formulations. Another 11.5 % of the area received a single application of aminocarb, and the balance (about 3.5 %) received a single application of undiluted bacterial insecticide **Bacillus thuringiensis**, (Bt) (Thuricide 48LV). Spray aircraft included TBMs, single-engine agricultural type spray planes and helicopters. Objectives of the program were to limit budworm defoliation and retain at least 60 % of the current year's foliage on balsam fir and 50 % of the current year's foliage on the red-black spruce complex and hybrids.

Analyses of defoliation data revealed that the program was very successful in meeting foliage protection objectives on all host species. Success, however, was qualified by observations from a high proportion of samples within untreated check areas which also experienced defoliation within objective levels. Besides variability inherent in operationally collected data, it was reasoned that spray-induced effects were influenced by cool spring temperatures and wet weather during the late larval stage which were conducive to good tree shoot growth yet unfavourable for budworm feeding.

Compared to 1983, there was a higher probability of naturally retaining specified levels of foliage across the range of larval densities encountered. Nevertheless, spraying increased the probabilities of attaining the levels of foliage retention in our specified objectives.

No clear and consistent differences between treatments could be determined because of the variable number of observations between treatments at each larval density. Mean plot defoliation estimates were generally lower in treated plots than in untreated plots though differences were not statistically different. Larval mortalities in unsprayed areas varied with prespray larval densities and ranged from 56 to 92 % on balsam fir and from 75 to 95 % on the red-black spruce complex. Insecticide-induced larval mortalities in treated plots ranged from 20 to 100 % on balsam fir and from 2 to 92 % on red-black spruce, with no consistent differences between treatments.

Combined aerial and ground defoliation surveys revealed about

0.73 million ha of moderate to severe defoliation in the larger more well-defined areas of damage. Widely scattered point observations of defoliation from the ground survey revealed more extensive damage but area estimates were not practical.

Results of the egg mass survey indicated that there were no changes in the proportion of plots in the low, moderate, and high categories between 1983 and 1984. This survey also indicated that about 3.57 million ha could be moderately to severely infested in 1985. Hazard values at the sample locations showed an overall improvement of tree condition as revealed by a 17 % reduction in the proportion of plots in the moderate or higher categories compared to 1983. This improvement was attributed to good shoot growth on host trees and less intensive feeds both in treated and untreated areas during 1984.

* For all authors' affiliations and addresses, see page 24.

EXPERIMENTAL SPRAYS

EXPERIMENTAL SPRAY TRIALS

E. G. Kettela

The objective is to develop practical, cost effective control practices for the spruce budworm that are more environmentally acceptable.

The approach is to review experimental spray trials against the spruce budworm in the Maritimes Region (1968 to 1983), development of new control strategies and development of more sensitive sampling methodology.

Accomplished to Date:

Since the start of spray operations in New Brunswick in 1952 there has been, every year, some testing of new products, new formulations, new approaches to spraying such as alteration of timing, number of applications, etc. Current use patterns of pest control products against the spruce budworm stem from these trials. The results of many of these trials appear in a variety of reports both internal and published. It is my intent to prepare a review of these research and development trials conducted since 1968, if for no other reason than "for the record".

During the past year, the data for this work have been assembled and mostly cleaned up ready for analysis. Some 250 individual tests have been catalogued and include tests with new chemicals, new formulations, anti-drift control agents, biological control products, stickers and surfactants, various applicaton rates, new equipment, timing (fir *vs.* spruce), insect growth regulators, the number of applications, and tests against the eggs and adults of the spruce budworm.

In 1984, test programs were conducted, with Forest Protection Limited(FPL), the New Brunswick Research and Productivity Council, (NBRPC), the Forest Pest Management Institute (FPMI) and a number of industrial sponsors and included, 1) reduced diluent trials with Matacil Flowable and fenitrothion, 2) test of *Bt* preparations - Futura, Dipel 176, and SAN 415, and 3) trials with Thuricide 32, 48 and 64 to relate concentration to efficacy.

These trials showed that acceptable results (foliage protection) could be attained with very low volumes of Matacil Flowable which equates to reduced cost, less material sprayed and a more cost-effective spray. This now needs to be tested on a semi-operational basis. Results with fenitrothion were not encouraging but should be repeated with the aim of determining why it was not successful. Trials with Futura showed that at 20 BIU/ha satisfactory results were obtained with the higher concentration sprays. Dipel 176 oil base, and Dipel aqueous preparations gave satisfactory results. The data generated have been forwarded to the company and included in the petition for registration. SAN 415, or as it is commonly known, NRD-12, was tested at three dosage rates, 15, 20, and 30 BIU/ha. No increased mortality was noted and no particular advantage over the currently used HD 1 strain appeared. The tests with the Thuricide products were conducted as part of a major research project involving FPMI, FPL, NBRPC and MFRC and demonstrate a clear relationship between efficacy and increasing concentrations of Bt. Problems were encountered initially in data interpretation but subsequently cleared up when data on Bt product potency were obtained. One of the products tested was found to be considerably understrength.

Current Status: All segments of this study are active. On the testing of products, this is normally a one-year-at-a-time event and any test can be reported within 1 year. Certainly the results with the reduced diluent trials are encouraging enough to pursue it actively and develop its full potential. This may take 2 or 3 years. The question of Bt concentration has been partially answered but must be taken further.

Plans for 1985-1986:

1) complete reports on 1984 spray trials,

2) complete the review of spray trials from 1968 to 1983,

3) carry out field tests with Zectran, Matacil Flowable, Sumithion Flowable, fenitrothion (reduced diluent), Dipel 176, Futura, and Thuricide,

4) continue in the joint research effort with RPC, FPL and FPMI on Bt efficacy.

EXPERIMENTAL AERIAL APPLICATIONS OF ZECTRAN UCZF-19 AND SUMITHION F20 INSECTICIDES TO CONTROL SPRUCE BUDWORM IN NEW BRUNSWICK IN 1984

B. L. Cadogan

A new formulation of mexacarbate, viz Zectran UCZF-19 and a flowable formulation of Sumithion (fenitrothion), viz Sumithion F20, were field tested in New Brunswick during 1984 to determine their efficacies against spruce budworm. Zectran was applied at 70 g a.i./ha in both water and in an oil mix (Cyclosol: canola oil: Shell ID585 at 1:2:3 v/v). Sumithion F20 was applied at 140 g and 210 g a.i./ha in water and these were compared against treatments of Sumithion technical insecticide applied in water at 210 g a.i./ha. The tree species sampled was balsam fir situated in 50 ha (1.0 x 0.5 km) treatment blocks. All treatments were applied twice in 1.5L/ha of tank mix using a Cessna 188 Ag-truck fitted with 4 Micronair Au3000 atomizers.

All the sprays atomized satisfactorily with the aqueous sprays producing narrower spectra (mean VMD = 63 um) than the oil ones (VMD = 101 um). Preliminary results show that Zectran in both water and oil gave 91 and 89% corrected population reduction and 17 and 9% host tree defoliation respectively. Sumithion F20 at 210 g a.i./ha resulted in 76% population reduction and 17% defoliation. Sumithion F20 at 140 g/ha showed 84% population reduction but we believe this block might have received off-target drift from an adjacent operational block. This hypothesis appears to be supported by the fact that the 140 g/ha block sustained 56% tree defoliation. The block treated with Sumithion technical showed 66% population reduction and 19% host tree defoliation.

The results indicate that Zectran UCZF-19 is effective in controlling spruce budworm and that Sumithion F20 is at least as good as Sumithion technical insecticide which is the product currently registered for use in Canada.

TOXICOLOGICAL PARAMETERS FOR EFFECTIVE FOLIAGE PROTECTION

P.C. NIGAM

<u>Objectives</u>: To elucidate mode of entry into, and action of insecticides in spruce budworm larvae and their microhabitat after operational or simulated aerial applications, and to determine their significance in foliage protection.

Accomplished to Date:

Direction Contact and Gross Residual Toxicity:

Direct Impingement: In 1982 at Magundy we observed spinning down of larvae from the foliage, within 15 to 30 minutes of spraying on June 4 and from 29 to 212 larvae were found on drop trays in different treatment plots within 24 h. In early spraying carried out May 19, 1983, no spinning down activity was observed and no larvae were found on the drop trays within 24 h. In sprays at Priceville on June 9, 1983 and June 5, 1984 there was also no sign of immediate spinning down of larvae within 15 to 30 minutes after spraying but 2 to 7 larvae were found on drop trays in treated plots within 24 h, and 2 to 4 larvae in check plots. The direct impingement of droplets on the larvae took place only under very special circumstances in the field. The favourable conditions were found in 1982 Magundy experiments when 60% of larvae were in the fifth instar, buds were flared, temperature at the time of spraying was 10°C and budworm larvae were active overnight as indicated by the presence of frass on the drop trays. The mean temperature was 10° C during the 24 hours observation period after spraying.

(b) Residual toxicity: Drop tray studies gave the gross effects of the interaction of various modes of entry, larval and host development stages and weather. After a June 4, 1982 spray, the average number of larvae found on drop trays decreased with time. After a May 19, 1983 spray, the average number of larvae increased with time and after a June 5, 1984 spray, the average number of larvae remained constant with time. The larval population in 1982 was 60% L5, in 1983 was 60% L2, and in 1984 was 43% L3 and 47% L4. L5 were more exposed to direct spray and relatively more active, so the maximum number of larvae dropped in the first 24 h and then decreased with time. L2 were in needles, so none dropped within 24 h. However, L2 eventually emerged from needles with warm weather and started dropping after 24 h and the number increased with time. In 1984, most of the larvae were L3 and L4 and they were in buds, so there was no change in the number of larvae dropping on the tray up to 4 da.

Vapour Activity: Effect of fenitrothion vapour on feeding behaviour of spruce budworm larvae was measured in the field by assessing damage to buds of branches protected from direct sprays, by covering them with paper bags during spraying and comparing the damage with damage to buds on neighbouring uncovered branches of the same tree, which were exposed to spray. Thus in the treated plots, covered branches were exposed to fenitrothion vapour only. In check plots, similar sets of covered and uncovered branches were maintained and were used in evaluation of results. The fenitrothion vapour in the air after aerial application was measured using NRC air samplers and chemical analysis was done by the Dr. L. Elias Laboratory at NRC, Ottawa. Observations on buds were done during field experiments of 1982 to 1984 but air was analysed only in 1983 and 1984. An apparatus to observe fenitrothion vapour activity under laboratory conditions against larvae was developed in co-operation with Dr. L. Elias during 1983-1984.

In 1982 at Magundy more damage was caused to covered unsprayed buds than to uncovered sprayed buds, i.e. vapour of fenitrothion had no affect on feeding behaviour of budworm. Vapour had not retarded their feeding. However, in 1983 and in 1984 there were not significant differences in covered and uncovered buds.

The highest vapour concentration observed after 6 h of spraying was 517 ng/m^3 in 1983 and it was reduced to a non detectable level after 72 h in most plots. In the 1984 field experiment, the highest concentration observed was 265 ng/m^3 after 14 h of spraying and it was reduced to a non detectable level after 72 h. There appeared to be no definite pattern of vapour plumes in these experiments due to effect of temperature. Wind direction may have had more bearing on the vapour concentrations recorded. Thus fenitrothion vapour does not appear to protect the foliage from spruce budworm larvae in the field.

The behavioural response of spruce budworm larvae to the field concentrations of vapours was observed in preliminary laboratory experiments, using a vapour chamber and an operating microscope. There were no noticeable changes in the behaviour of L3 to L6 larvae at vapour concentrations up to 20x the field concentrations. There were no poisoning symptoms i.e., hyperactivity or spinning down of larvae from microhabitat or from current year's foliage of potted plants.

Approximately 60 to 80% fenitrothion is lost from foliage in 3 da under field conditions. Fenitrothion is more than 31.6x as volatile as aminocarb. Its evaporation from foliage is approximately 48x faster than that of aminocarb. The efficacy of fenitrothion could be increased 2 to 3x, i.e. to the level of aminocarb, by reducing its evaporation from

foliage, thereby increasing its residual toxicity. This should be attempted by changes in the formulation of fenitrothion, without reducing its contact and stomach toxicity.

Systemic Activity: Systemic activity of fenitrothion was measured by covering buds with Plasticine during spraying so that individual buds were shielded from deposition of spray droplets. Neighbouring foliage and buds remained exposed. It was hypothesized that insecticide from the neighbouring foliage and buds would translocate through xylem and phloem transport systems. There was some translocation of fenitrothion after 72 h of application as measured by chemical analysis. These results were confounded by the resinous material in buds during early season and drift from operational spraying. It was not possible to demonstrate a biological significance of this translocated chemical due to high mortality of larvae in the foliage bioassayed from check plots, which had been contaminated by drift.

The vapourized fenitrothion does not contibute directly to foliage protection. If this vapourization is reduced by modification in formulations then efficacy of fenitrothion could be increased substantially.

RESIDUES

ZECTRAN DEPOSITS ON SIMULATED AND LIVE FIR NEEDLES AT PERIPHERY OF TREE CROWNS AND AT GROUND LEVEL DURING AN AERIAL SPRAY TRIAL

K. M. S. Sundaram

Mexacarbate deposits on simulated and live balsam fir needles were measured at different crown heights using aluminum coils as the simulated foliar surface, following aerial application of two (oil-based and water-based) spray formulations in New Brunswick. Ground deposits of the material were measured using Kromekote card-glass plate units and air concentrations using impingers. Deposits on the aluminum coils and foliar concentrations decreased from the upper to the lower crown, and the ratio of the amounts in top, middle and bottoms levels was 3:1:1. Regression analysis showed an approximately linear relationship between the deposits at the tree crown level and those on the ground samplers. The air concentrations showed a poor correlation with the rest of the deposit data, probably due to the trapping of both droplets and vapour, unlike the other samplers which collected only the droplets.

ZECTRAN RESIDUES IN SOME TERRESTRIAL COMPONENTS OF A CONIFEROUS FOREST FOLLOWING AERIAL APPLICATIONS OF SPRAY FORMULATIONS

K.M.S. Sundaram

Mexacarbate insecticide has a potential for widespread use in spruce budworm control operations in Canada. Its persistence and fate in balsam fir, litter and soil samples were studied by spraying aerially an oil-based and a water-based formulation separately, each 70 g a.i./ha over a coniferous forest near Bathurst, New Brunswick. The oil-based formulation gave the maximum concentration of the chemical in the substrates studied. In fir needles, the highest concentrations 1 h after application were 0.51 ppm and 0.19 ppm (fresh weight) for the oil-based and emulsion formulations respectively. The residue decreased very rapidly and within 5 h nearly 50% of them were lost. Eight days and 3 d after the spray application of the oil and emulsion formulations respectively, the concentrations of mexacarbate in foliage decreased to trace (<0.008 ppm) and then disappeared. Only very low residues were detected in litter and soil. The peak concentrations for the two formulations ranged from 0.02 to

0.11 ppm (fresh weight) in litter and from 0.01 to 0.06 ppm (fresh weight) in soil. The residues in both litter and soil were lost within 1 d to below the detection limit (0.005 ppm). The ground deposits found on glass plates and the droplet density and size spectra measured on Kromekote cards reflected the variations in concentrations found in fir needles, litter and soil samples and had correlated with the observed maximum concentrations in them. Under the stipulated use pattern, mexacarbate concentrations found in the terrestrial components studied were too low to have any undue adverse effects on non-target species.

THE ACCUMULATION AND PERSISTENCE OF FENITROTHION IN NEEDLES OF BALSAM FIR AND EFFECTS ON ABUNDANCE OF NEODIPRION ABIETIS (HYMENOPTERA, DIPRIONIDAE)

D. C. Eidt
and
V. N. Mallet

Abstract*

It is demonstrated that fenitrothion accumulates in balsam fir foliage tissue with successive years of spray, but only until a capacity of about 1.5 ug/g is reached. The balsam fir sawfly, Neodiprion abietis, which is among the most sensitive species of forest insects to fenitrothion, has become rare in New Brunswick since the use of fenitrothion for spruce budworm control began,but still persists.

* from a manuscript under review. Based on residue data from September-October 1983, and N. abietis data from The Forest Insect and Disease Survey (FIDS) 1969 to 1980.

PERSISTENCE OF FENITROTHION IN BALSAM FIR LEAF LITTER

D. C. Eidt, V. N. Mallet, and C. A. A. Weaver

An outstanding unanswered question is how long does fenitrothion persist in needles on the forest floor. On July 9th, 19 bags containing over 30 g of foliage were deposited on the forest floor in the University of New Brunswick woodlot. This foliage had been collected in a heavily sprayed area several weeks after spray so that the surface deposit should have been lost. The entire foliage collection was thoroughly mixed and two bags were immediately analysed to determine the starting concentration of fenitrothion. Samples of two bags were collected at intervals to develop a degradation curve. Results to date are:

Date	Mean of two bags (ug/g)
9 July	0.32
13 July	0.22
16 July	0.30
23 July	0.30
7 Aug.	0.33
28 Aug.	0.23

It became clear that decomposition was extremely slow so no further samples were taken in 1984, because only 9 bags remained. The next bag will be collected as soon as possible after snowmelt. The following one will depend on the results of analysis.

TERRESTRIAL IMPACTS

IMPACT OF EXPERIMENTAL AERIAL APPLICATIONS OF ZECTRAN INSECTICIDE ON FOREST SONGBIRDS IN NEW BRUNSWICK, 1984

S. B. Holmes
and
D. Busby

A joint Canadian Forestry Service/Canadian Wildlife Service study to investigate the impact of Zectran (mexacarbate) spraying on forest songbirds was conducted near Bathurst, New Brunswick in June, 1984. Two 300 ha blocks of mature spruce-fir forest were treated by aerial application with a water emulsion formulation of Zectran UCZF-19 insecticide, one with a single dose of 70 g a.i./ha and the other with two consecutive doses of 70 g a.i./ha each to simulate overswathing. Brain cholinesterase (ChE) activities of several species of forest songbirds collected in the two spray blocks were compared to untreated controls from an area of unsprayed forest nearby. In addition wild White-throated Sparrows were caged in the double application block and their ChE activities were compared to birds caged in the control area. Aerial spraying of Zectran, even at twice the recommended dosage rate, had only a slight inhibitory effect on the brain ChE activity. A small number of the 289 birds collected from the two spray blocks did exhibit relatively high levels of ChE depression, however. ChE inhibition was greater in the double application block than in the single application block. A negative correlation was established between the amount of spray deposited on the floors of bird cages and the ChE activity of the birds in those cages.

EFFECTS OF FENITROTHION AND AMINOCARB ON FOREST LITTER DECOMPOSITION

D. C. Eidt and C. A. A. Weaver

A paper on the effects of fenitrothion and adjuvents on decomposition of white spruce needles in litter bags on the forest floor is due to appear in the Canadian Journal of Forest Research early in 1985. Further studies using aminocarb with Triton 114F, aminocarb with Atlox 3409F, and fenitrothion with Triton 114F have yet to be reported but the work is now complete and a report has been drafted. The results and final analysis indicate that neither the aminocarb formulations at ground application rates of 140 g a.i./ha and 1400 g a.i./ha nor the fenitrothion formulation at 420 g a.i./ha and 4200 a.i./ha had an

effect on decomposition rates of balsam fir needles in litter bags, as indicated by loss of weight.

AQUATIC IMPACTS

AQUATIC IMPACT STUDIES ASSOCIATED WITH EXPERIMENTAL ZEIRAPHERA CONTROL PROGRAMS USING PERMETHRIN IN NEW BRUNSWICK, 1984.

S. B. Holmes

Aquatic impact studies were conducted in five streams near blocks experimentally sprayed with permethrin to control spruce budmoth populations. The two blocks were sprayed at dosage rates of 35 and 70 g a.i./ha. Populations of benthic organisms in the streams were not reduced post-spray. Increased drift of Leuctra stonefly nymphs was noted in two streams (44X and 72X pre-spray drift) on the evening that the 70 g a.i./ha block was sprayed. These two samples were collected at 1015 and 1030 PM, however, at a time when many insect taxa including Leuctra enter the drift naturally in response to the onset of darkness. Populations in the study streams did not change.

TOXICITY OF BACILLUS THURINGIENSIS KURSTAKI TO VARIOUS AQUATIC INSECTS

D. C. Eidt

Early in 1984 difficulty was found in obtaining a permit to use Btk in forests adjacent to watercourses because not enough information was available on the risk to aquatic arthropods to waive the 65 m buffer zone. A variety of freshwater insect larvae were collected in late February and early March and reared in the laboratory in water from their natural habitat which contained 4.3, 43 or 430 IU of Btk/mL.

Larvae of the black fly, Simulium vittatum were clearly affected at 430 IU/mL where 50% mortality occurred by about 20 da. Results at lower rates did not differ from the control and emergence occurred at all concentrations. An effect was suggested on Prosimulium fuscum/mixtum, which emerged only in the control and the lowest concentration at the briefest exposure. Other insects showed no mortality effects at any concentration. These were the caddisflies Chimarra and Hydropsyche, the midges Tanytarsus sp. and Procladius ruris, mayflies Leptophlebia, dobsonflies Nigronia serricornis, and stoneflies which was a mixture of Leuctra spp. and Allocapnia spp. Emergence of midges, stoneflies, and mayflies occurred, but never at the highest concentration.

The lowest concentration used was about twice the estimated worst-case field concentration, therefore, it was concluded that Btk as used in budworm spray operations poses no hazard to these aquatic insects nor probably also for aquatic insects in general.

Work by Eco-Analysts Inc.* of Bath, Maine, showed that the gut pH of the caddisflies Anabolia, Neophylax, Pycnopsyche, Rhyacophila was too low to dissolve the crystolline toxin which causes the septicemia. Gut contents of the two hydropsychids, added to budworm diet, were adequate to kill and retard development of budworms.

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* Eco-Analysts, Inc. 1981. The effects of Bacillus thuringiensis on Trichoptera. pp 134-163 in Environmental monitoring reports from the 1981 Maine Cooperative Spruce Budworm Supression Project, Maine Forest Service, Augusta.

AQUATIC IMPACTS OF AMINOCARB FLOWABLE AT 180 A.I./HA

W. Ernst and G. Julian

In 1984 aminocarb flowable at twice the usual dosage rate was tested on spruce budmoth in white spruce plantations by the Forest Pest Management Institute (FPMI). The Environmental Protection Service (EPS) conducted a study to determine the impact of these high dosage rate aminocarb applictions on a stream ecosystem. This project was complementary to an aminocarb fate and persistence study conducted at the same site by the Inland Waters Directorate (IWD).

Matacil 180 F was applied at 180 g a.i./ha directly to approximately 300 m of a stream, located within the experimental spray block. The water formulations (5 L/ha) were sprayed by a Thrush Commander equipped with Micronair spray units.

Before and after spray, measurements were made of:

a) stream invertebrate populations on artificial substrates; drift; and

b) brain acetylcholinesterase activity of brook trout held in cages within the stream.

The original intent was to have most of the upstream portion of the stream sprayed; however, a failure in communications with spray operators resulted in a much smaller portion of the stream being sprayed. The aircraft spray booms were shut-off approximately 100 m upstream of the sampling site.

Stream invertebrate drift increased slightly from 1/2 to 8 h after spray. The increased drift was composed primarily of Ephemeroptera (Heptageniidae) and Plecoptera (Taeniopterigidae). Indentification of artificial substrate samples is not yet complete.

EFFECTS OF FOREST SPRAYING ON THE INVERTEBRATE COMMUNITY OF BOG PONDS

W. L. Fairchild and D. C. Eidt

Bog ponds have been identified as areas with high potential for deleterious effects due to forest spraying. Small water volume, limited flow, low pH, high organic matter content, large vegetation/water interface and a lack of forest canopy cover are all factors contributing to this potential.

In 1984 a study was initiated to test fenitrothion and aminocarb on five bog ponds near Lake George, New Brunswick. Four ponds were used to set up a design where 4 different fenitrothion treatment combinations could be tested in 2 years as follows:

Pond	1984	1985
1	0	0
2	0	X
3	X	0
4	X	X

0= No spray X = two sprays (210 g a.i./ha each)

A fifth pond nearby was treated with aminocarb (70 g a.i./ha then 210 g a.i./ha) in a separate test using ponds 1 and 2 of the fenitrothion experiment as controls. All sprays were applied from a boat with a Solo backpack mistblower.

Pesticide residue analysis (XAD resins and GLC) indicated peaks of 80.6 ug/L fenitrothion within 5 h post spray; peak level at 3 da post spray was about 17.0 ug/L.

Measurable residues (3.8-14.6 ug/L) were still present 3 wk after the second spray but became non-detectable sometime between 6 wk and 3 mo postspray.

Qualitative results for fenitrothion include a decrease in odonate (dragonfly) activity observed in the field and a large kill of notonectids and corixids (aquatic "true bugs"). Similar changes were not apparent in the aminocarb pond. Quantitative results showed a complete loss of the gyrinid population in only the fenitrothion ponds. Recovery to near control levels took the gyrinids 40 da. Organisms of the sphagnum fringe and emerging insects declined in the fenitrothion treated ponds, however, it is too soon to make any reliable statement of effect. Analysis of faunal samples is still in progress.

In 1985 the second year of fenitrothion spraying, efforts will be made to answer questions arising from 1984 results. Plans for aminocarb are open, with a decision on spraying pending.

TOXICITY OF MEXACARBATE AND ITS FORMULATION UCZF-19 TO JUVENILE ATLANTIC SALMON (Salmo salar)

L. Burridge, M. Woodside, V. Zitko, and L. Haya

The acute toxicity of mexacarbate (Zectran) and its proposed formulation, UCZF-19, to juvenile Atlantic salmon has been determined. The 96-h LC50 of technical mexacarbate is 19.5 mg/L. The 96-h LC50 of the UCZF-19 formulation (expressed as mexacarbate) is 3.4 mg/L. Preliminary tests indicate that the solvent used in the UCZF-19 formulation is the cause of the increased toxicity.

BRAIN CHOLINESTERASE ACTIVITY AND PESTICIDE UPTAKE OF FISH EXPOSED TO AMINOCARB AT VARIOUS AMBIENT pH

K. Doe, W.Ernst, R. Parker, and P. Hennigar

A laboratory bioassay study was undertaken to determine the effect of exposure pH on brain acetylcholinesterase and pesticide uptake in brook trout exposed to aminocarb. This study was undertaken in an attempt to further explain some observations previously reported to EMOFICO, that exposure pH modifies pesticide toxicity. The previous Environmental Protection Service (EPS) study indicated that increasing the pH from 4.5 to 8.5 decreased the toxicity of the acid pesticide 2,4-D more than 15 x and increased the toxicity of the base pesticide aminocarb by approximately the same amount. The toxicity of the neutral pesticide fenitrothion was not altered by changing the exposure pH.

In the follow-up investigation, fish were exposed to 10 mg/L aminocarb at pH 4.5 and pH 8.5. For the first 6 h of exposure, aminocarb concentrations in whole fish (less heads) were similar at both pH's and ranged from 6.2 to 12 ug/g. After 6 h, however, aminocarb concentrations in pH 4.5 exposed fish declined to 1 to 2 ug/g and remained low until the end of the test (72 h), while tissue concentrations in fish exposed at pH 8.5 remained elevated until all fish had died by 72 h. Brain AChe activity was inversely related to aminocarb concentrations in fish tissue. At pH 4.5, brain AChe activity dropped to 58% of that of control fish by 6 hours and increased to levels similar to those of control fish by the end of the test. At pH 8.5, however, brain AChe activity dropped to 40% of that of control fish by 6 h and remained depressed until all fish had died by 72 h.

These results are in reasonably close agreement with the theory that the toxicity of a particular organic chemical is dependent upon the degree to which it is ionized at a particular pH. Aminocarb is 6.6% undissociated at pH 4.5 and 99.9% undissociated at pH 8.5. Thus, according to the pH partition theory, we would expect greater than 10 x more aminocarb to enter fish tissues at the highter pH. This was the case at 24 h exposure and beyond, but for the first 6 h of the experiment, aminocarb uptake was similar at both pH's. Various mechanisms are possible, but at present we have no conclusive explanation for the unexpectedly large tissue residues at pH 4.5 for the first 6 h exposure. Their effects were marked, however, depressing brain AChe activity and causing the fish to become sluggish. Only when tissue residues declined at pH 4.5 (after 24 h) did these sublethal effects begin to disappear.

OTHER MONITORING PROGAMS

ENVIRONMENTAL MONITORING IN NEWFOUNDLAND AND LABRADOR, 1984

S. Bonnyman

Environmental monitoring of the spruce budworm spray program has been conducted in Newfoundland since 1977. Monitoring has been continuous, including several years when an operational spraying campaign was not necessary. The objective of the monitoring program is to determine if aerial application of aminocarb have any impacts on non-target species.

The 1984 monitoring program was reduced in size and cost, and will continue to be phased down over the next two years, in accordance with the recommendations of the Royal Commission on Forest Protection and Management. Field studies on bird communities ceased, while a comprehensive analysis of the existing bird community data base was initiated. Aquatic invertebrate studies continued, examining diurnal drift and the bottom dwelling community, using artificial substrates. In 1984, treatment of one pair of control-experimental streams was reversed, in order to determine if spraying for several years had resulted in depressed biomass levels in experimental streams as compared to controls. The absence of a full year of appropriate pre-spray data in experimental streams made resolution of this problem impossible, without such a change in design.

The aquatic study will be continued into 1985. A pollinator study will be initiated in 1985, and continue to 1986.

ENVIRONMENTAL MONITORING IN MAINE, 1984

S. Oliveri

The State of Maine continued the long-term environmental monitoring study and added a study of spruce budworm parasites as a major part of this effort. These multiple year projects are the only ones planned for Maine for the foreseeable future.

Long Term Environmental Monitoring (LTEM) Study. Conducted by Eco-Analysts Inc., Georgetown, Maine and the Maine Forest Service. The LTEM Study was designed in 1982 by a multidisciplinary team of scientists at the University of Maine. It encompasses field monitoring of aquatic invertebrates, fish, birds, tree condition, budworm, and budworm parasites on 22 permanent forest plots. The plots are distributed throughout the northern, central, and eastern portions of the state. Plots are

located in spruce-fir forest stands, some of which are to be sprayed operationally with chemical insecticides, some with Bt and the remainder to be left unsprayed.

1984 was the second year of field data collection; the project is slated to last for 5 years. All of the parameters will be analyzed and an attempt will be made to model the interactions between environmental components, as they are influenced by either insecticide application or defoliation and tree mortality caused by spruce budworm.

Because this is slated to be a multi-year project, analysis of the first 2 years' data is not complete. There are 2 reports available. The first year report is contained in the Environmental Monitoring Reports from the 1983 Maine Spruce Budworm Suppression Project. The preliminary report for the 1984 field season summarizes data collection for the second year of the project.

Monitoring of Spruce Budworm Parasites. Conducted by David Struble, Maine Forest Service. The objectives of this project are to measure and compare long-term responses of late-larval and pupal spruce budworm parasites to operational applications of Bt and chemical insecticides as well as within untreated control areas. Study plots have been established containing five 25 tree sample lines (fir only) for each of the treatment and control areas. Budworm populations are determined by pruning branches from sample trees and counting larvae. Larvae are also reared in the laboratory to determine parasitism rates.

In addition, at 3 sites in each treatment area, arboreal Malaise traps were established to obtain an index of abundance of free-living adult parasites.

The study is expected to take place over a 3-5 year period, to more accurately reflect long-term trends and to decrease the amount of uncertainty that can be caused by seasonal fluctuations such as short term vagaries in weather or other environmental parameters.

A preliminary analysis of the first year's data has been conducted. A few general trends have been noted, but sample size is small and these trends may not persist over the entire period of the study. In general it appears that neither insecticide treatment enhanced late-larval/pupal parasitism rates above the naturally occurring levels in the unsprayed areas.

The Malaise trap results indicate a reduction of adult tachinids active in the fir canopy during the late-larval/pupal spruce budworm stages in both the Bt and Zectran treated areas. While direct mortality of tachinids is a possibility with Zectran, the similar trend in the Bt treated area indicated that this phenomenon may be a response to lessened host density (eg. less attraction to scent of frass or chewed foliage).

The unsprayed and Bt-treated areas had similar and appreciably greater abundance of hymenopterans than did the Zectran-treated area. These catch results support the hypothesis of direct mortality caused by the Zectran treatment.

Continued monitoring of the spruce budworm and parasite larval densities and of the adult parasite abundance will be necessary to evaluate long term effects of these treatments. Interim reports will be generated, but final results will be incorporated into the Long Term Environmental Monitoring report.

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